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May 15, 2000

Ms. Gwen Zervas
Case Manager
New Jersey Department of Environmental Protection (NJDEP)
Bureau of Federal Case Management
Division of Responsible Site Party Remediation
CN 028
Trenton, NJ 08625-0028

Subject: L.E. Carpenter & Company, Wharton, New Jersey
Free Product Remedial Alternative Analysis

Dear Ms. Zervas:

This letter has been prepared by RMT, Inc. (RMT), on behalf of L.E. Carpenter and Company (LEC), to respond to the comments outlined in the NJDEP letter dated April 13, 2000 regarding the departments review of the Quarterly Monitoring Report - 4th Quarter 1999 dated January 2000. This letter accompanies RMT's report regarding modeling of recoverable free product. In addition, we have also conducted a study of Remediation by Natural Attenuation (RNA), and also attached for your review a report that summarizes that study. RMT recommends that dissolved phase constituents downgradient of the free product area be addressed via RNA as documented and supported by the attached report. We also recommend that the results of this study be used to re-evaluate the required timeline for free product recovery.

As detailed in the attached free product modeling report, extraction of the remaining volume of free product cannot be achieved within a two-year period of time using the existing recovery methodology currently in operation. Therefore, as indicated in the April 13, 2000 letter, we propose herein to evaluate more aggressive remedial technologies for the removal of free product.

BACKGROUND

Subsurface investigation and remedial action activities have been ongoing at the former LEC facility since the Administrative Consent Order was executed in 1986. Free product removal was identified in the 1994 Record of Decision (ROD) as Phase 1 of remediation for site groundwater, to be followed by Phase II, recovery and treatment of dissolved constituents in the groundwater once the immiscible product layer was removed. Current dissolved phase contaminants of concern in the groundwater are benzene, toluene, ethylbenzene, and xylenes (BTEX) and bis (2-ethylhexyl) phthalate (DEHP). Based on the analytical results of free product sampling conducted by Roy F. Weston (WESTON) in February 1995, the free product layer is the major source of dissolved phase BTEX and DEHP contamination in shallow groundwater.

Free product recovery was initiated during the early 1990's, first with skimmer pumps in select wells, and then with enhanced fluid recovery (EFR) over a large number of wells in the free product zone. Since November 1997, RMT has been performing monthly EFR events from a network of 28 EFR wells by means of mobile vacuum source. Extracted free product and limited volumes of groundwater are transferred to an on-site 550-gallon aboveground storage tank for eventual transportation and disposal. Current and historical free product extraction volumes range from 50 to 60 gallons of measurable free product per EFR event (600 to 720 gallons per year). However, the total estimated volume of free product is approximately 44,000 gallons, of which only a fraction (8,000 to 13,000 gallons) is likely to be recoverable, based on experience from other sites (see USEPA publication EPA 510-R-96-001). It is estimated that it will take between 13 to 22 years to remove all of the recoverable volume of free product using the EFR system currently in operation.

The following presents options that have been identified for further evaluation of their feasibility for the site.

ALTERNATIVE NO. 1: IN-SITU CHEMICAL OXIDATION UTILIZING FENTON'S CHEMISTRY

This methodology for treatment of organic compounds was first introduced by H.J.H Fenton in the 1890's, and has been widely studied, utilized and proven effective by the wastewater industry. The underlying principle is to take the proven chemical reaction (Fenton's Reagent) from the wastewater industry and apply it in the subsurface. The chemistry utilizes hydrogen peroxide and trace quantities of metallic salts (the catalyst) to create a hydroxyl free radical; an extremely powerful oxidizer of organic compounds.

This method will deliver a calculated amount of hydrogen peroxide and catalyst to the contaminated region through the use of a pressurized, closed injection process. The injectors contain mixing heads, which promote rapid and even distribution of reagents throughout the impacted zone. Injectors are installed in a vertical and horizontal array to ensure the reagents disperse throughout the entire contaminant plume. During the reaction, the organic contaminants are converted to shorter chain mono- and di-carboxylic (fatty) acids, which are non-hazardous, naturally occurring substances. Subsequent reactions further degrade these substances into carbon dioxide and water. Reaction progress and efficiency are monitored by measuring CO_2 and O_2 outgassing from adjacent wells. CO_2 is a product of the oxidation of the carbon bonds of organic contaminants, and O_2 is produced when hydrogen peroxide decomposes in the absence of organic contaminants. Remediation is complete once CO_2 levels drop to near detectable limits and O_2 levels have increased and plateaued. The efficient creation of the hydroxyl free radical in contact with the contaminant, the effective radius of influence from each injector, and a safe and economical delivery make in-situ oxidation with Fenton's chemistry a viable remediation alternative.

The initial step in evaluating the feasibility of Fenton's Chemistry at LEC will be to collect representative saturated soil samples in areas of free product at the site. Sample locations will be selected to represent zones of thick free product, and varying soil types (sand, silt/clay). A quantitative laboratory analysis will then be conducted to determine initial (pre-treatment) DEHP and VOC concentrations (including BTEX as well as other VOCs and SVOCs included on the SW-846 8260 & 8270 lists), in the two soil samples. Once baseline VOC and SVOC concentrations have been established, a lab treatability test (bench scale study) of two soil samples containing free product from the site will be performed using chemical oxidation techniques to confirm that existing concentrations of BTEX and DEHP can be treated effectively in site soils. The bench scale study will evaluate whether the free product in product-saturated soil samples is degraded completely or to a degree by chemical oxidation (the degree of degradation will be quantified). The presence of possible by-products of concern will be evaluated by analysis of VOCs and semivolatile organic compound (SVOC) constituents in the soil samples, before and after treatment.

The results of the lab treatability test of chemical oxidation of free product will be included in the free product focused feasibility study, and will summarize the findings and conclusions of the test.

ALTERNATIVE NUMBER 2: FRENCH DRAIN/RECOVERY TRENCH

Whereas, chemical oxidation (described above) could be employed to destroy free-phase product in-situ, more aggressive collection and extraction technologies could be employed to physically recover free phase product more effectively from the subsurface. Evaluation of collection trench/french drain methodology is proposed, as free product will tend to accumulate within a more permeable trench than within less permeable native subsurface soils, thereby enhancing collection and extraction. Collection trenches can be installed to bisect the free product plume and maximize recovery rates. Trenches have considerably more surface area than well points through which free product may flow, which enhances the rate of recovery.

Maximizing product recovery from the area surrounding the trench is directly related to the amount of influence (pressure gradient) the extraction technology utilized to remove the product from the trench can induce. A recovery trench generally operates at atmospheric pressure, inducing flow of product and water by lowering the water table. Alternatively, a vacuum can be applied to horizontal well screens placed in the trench, utilizing multi-phase extraction methods to maximize the removal of product and vapor, and minimizing the extraction of groundwater. By placing well screen at multiple levels in the trench, adjustments can be made for seasonal fluctuations in the water levels by pumping from the appropriate well screen. If a vacuum is to be applied to the extraction trench, the trench must be effectively sealed from the surface with a low-permeability cover. However, fluctuations in the water table and product layer can present difficulties and reduce the efficiency of the system when maximizing product recovery while minimizing groundwater recovery is the prime objective. As a result, the feasibility analysis of a recovery trench will incorporate various design considerations to maximize the recovery of free product and minimize groundwater recovery. Trench design considerations will include, but are not limited to surficial trench liners/trench caps to maintain efficient vacuum and maximize the capture zone, and multiple vertical screened intervals within the extraction sumps/risers to compensate for fluctuating water table elevations. Various extraction methods will also be evaluated for use within the trench system. These will include, but are not limited to skimmer pumps, submersible pumps, belt skimmers and liquid ring pumps, or various combinations.

A simplified single layer groundwater flow model that simulates the effects of a trench system collection system on free product recovery rates would be utilized to estimate the extent of the capture zone of the trench given various design considerations. Site-specific hydraulic data and boundary conditions will be incorporated into the model to allow for a representative model of the site to be constructed. For the purposes of the focussed feasibility study, the model will be useful in evaluating the conceptual design of the extraction trench system. The model can also be used to predict the rate of recovery and the expected project duration under each design based on the estimated recoverable volume of free product at the site.

Although, the design will focus on recovery of free product, a certain volume of extracted groundwater is anticipated. Subsequently, this study will also address product water separation, groundwater treatment, disposal and discharge, and corresponding permit issues.

ALTERNATIVE NUMBER 3: MULTIPLE-PHASE EXTRACTION WITH WELL POINTS

Multiple-phase extraction (MPE) is an *in situ* technology that uses a single, high-vacuum pump to extract liquid and vapor simultaneously from the subsurface. Extracted liquid and vapor are treated and disposed, or discharged. The vacuum applied to the subsurface with MPE systems creates vapor-phase pressure gradients toward the vacuum well. These vapor-phase pressure gradients are also transmitted directly to the subsurface liquids, which will flow toward the vacuum well in response to the imposed gradients. The higher the applied vacuum, the larger the hydraulic gradients that can be achieved in both vapor and liquid phases and thus, the greater the vapor and liquid recovery rates.

Several extraction wells would be connected to a single high-vacuum pump, usually a liquid-ring vacuum pump capable of producing over 400 inches water column (in. H_2O), or 29 inches mercury (in. Hg) vacuum. In each well, an extraction tube (also known as a "spear" or "stinger pipe") is installed with its tip at the elevation to which drawdown of the groundwater is to occur. The extraction tubes are connected to the vacuum pump via manifold piping. Because the vacuum that is applied induces a substantial pressure gradient to the well, product flow to the well will be significantly enhanced, compared to pumping liquids only from a well. MPE can be significantly more effective in product recovery than pumping liquids only, in lower permeability formations, such as the upper stratum of silty sand and sandy silt at this site.

It is important to minimize the amount of groundwater that would be extracted, while maximizing the amount of product extraction. Adjusting the amount of vacuum applied to the well, which causes upconing of the water table, with the elevation of the stinger pipe, can effectively balance the upconing/drawdown effects, and preventing smearing of the product in the formation. In this way, product recovery can be maximized and groundwater extraction is minimized.

Within the free product area, the MPE extraction system would be connected to multiple wells. If judged feasible, the existing EFR wells could be used; alternately, additional wells might be installed specifically for this purpose. Multiple liquid ring pumps would be connected to the extraction wells, downstream of a knockout tank and water product separator. Placement of the liquid ring pumps downstream of the knockout tank/air water separator would prevent the liquid ring pumps from direct contact with the fluids, thus avoiding the historical pump maintenance problems associated with pumps at the site that were in contact with the product.

Recovered product would be removed from the site for disposal. The extracted groundwater would likely be treated on site with an appropriate technology that is to be determined. Treated groundwater would then need to be disposed, either through an infiltration gallery, injection well(s) or the sewer system. Appropriate permits for disposal of treated groundwater would need to be obtained, with assistance from the USEPA and the NJDEP.

The MPE well system would also be evaluated using a groundwater flow model of the site to estimate the zone of capture of each extraction well. Using site-specific hydraulic conductivity data and boundary conditions, the model would evaluate the capture zone of the wells under various levels of vacuum, so that appropriate placement and number of wells could be estimated. This analysis would be intended to provide a sufficient amount of information to evaluate the feasibility of using MPE with extraction wells at the site. If this remedial measure were eventually selected for implementation, pilot testing at the site would be conducted to refine the design parameters for the system.

FOCUSED FEASIBILITY STUDY REPORT

The results of each free product remedial option evaluation will be presented is a concise focused feasibility report. The report will include the following information:

- explain the methodology behind each option,
- discuss the results of any modeling and/or testing performed to provide insight into option viability,
- outline the potential recovery rates and time frames associated with product removal under each option,
- evaluate associated costs with each option, and
- make a recommendation regarding the remedial technology deemed most appropriate for implementation.

LEC requests that following your receipt and review of these materials, a meeting be arranged in order to discuss these issues.

Sincerely,

RMT, Inc.

Nick Clevett GK

Nicholas J. Clevett
Project Manager

cc: Cris Anderson - LEC
Jim Dexter - RMT
Galen Kenoyer - RMT
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